Deployment & Traveler's Diarrhea

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Lecture Objectives

- Definitions
- Scope of disease and Epidemiology
- Acute Diarrhea
  - Pathogens involved
- Chronic Diarrhea
  - Pathogens involved
- Diagnosis
- Treatment
- Prevention

Diarrhea Deaths

- **Second only to cardiovascular disease as a cause of death worldwide**
  - **Leading cause of childhood death**
  - **5-6 million children die annually in Asia, Africa and Latin America**
  - **~10,000 children die annually in the US**
  - **Averages of 7-19 cases per child per year in some areas**
- **Deaths in adult travelers with diarrhea are rare**

Pediatric Deaths due to Diarrhea

Table 5. Global estimates of the annual number of diarrhea and rotavirus deaths among children <5 years of age, by income group

	Total no. (x1,000)		Diarrhea deaths		Rotavirus deaths[b]		
Income group	Births	Deaths	Median % (IQR[a]) of total deaths	Median no. (IQR) of deaths (x1,000)	Median % (IQR) of diarrhea hospitalizations	Median no. (IQR) of deaths (x1,000)	Risk of dying from rotavirus by age 5
Low	70,447	8,595	21 (17–30)	1,805 (1,461–2,579)	20 (16–27)	361 (289–487)	1 in 205
Low middle	37,402	1,609	17 (11–23)	274 (177–370)	25 (20–33)	69 (55–90)	1 in 542
Upper middle	11,520	366	9 (5–17)	33 (18–62)	31 (25–42)	10 (8–14)	1 in 1,152
High	9,931	60	1	<1	34 (28–38)	<1	1 in 48,680
Total	129,300	10,630	NA	2,112 (1,657–3,012)	NA	440 (352–592)	1 in 293

Parashar et al; Global Illness and Deaths Caused by Rotavirus Disease in Children EID;9 (5):165-172, 2003

Traveler's Diarrhea
Prevention and Self Management

- **The risk of traveler's diarrhea for each week spent in a developing nation is 20 - 25%.**
  - **Varies from country to country, and in different areas in one country.**
  - **Rates of 40 - 60% are not uncommon with several weeks travel.**
- **Mortality has not been described.**
- **Morbidity may be significant.**
  - **Untreated cases last an average 3 - 4 days.**
  - **Affected persons average 17 unformed stools.**
  - **Cramps, nausea, vomiting, and fever may be present.**

Traveler's Diarrhea
Definitions

- **Healthy person < 150 mL (of liquid in) stool in one or more BMs per 24 h**
- **A patient with diarrhea often passes > 200 mL of liquid in stool in > 3 unformed movements in 24 h.**
- **If < 150 mL total liquid volume, generally considered "loose stools" and not diarrhea**
- **Traveler's Diarrhea is defined as ≥ 3 unformed stools passed in 24 h and at least one associated symptom of enteric dz:**
  - **nausea**
  - **vomiting**
  - **abdominal pain**
  - **fever**

Traveler's Diarrhea
Associated Risks

- Rural areas and tropical climates associated with > risk than cooler climates and urban areas.
- The major source of infection appears to be food.

  Food cultures may reveal bacterial contamination equivalent to feces.
- Water-associated diarrhea typically caused by viruses or parasites > bacteria.
  - Freezing decreases, but does not eliminate, bacteria in water.
  - Heating to boiling for one minute destroys most pathogens.
  - Boiling for five minutes is recommended to kill all pathogens.

Are you eating food or feces?

- **Fecal contamination determined by presence of *E.coli* in food from Guadalajara:**
  - **28 hot sauces from 12 restaurants**
  - **67 - 100% of the different sauces were contaminated**
  - **mean number of colony counts: 3,100 - 13,500 colonies/gram (some with 30,000)**
- ***E. coli* contamination in Mexican restaurants in Houston:**

  40% of 25 sauces contaminated with a mean of 3.6 colonies per gram.

DuPont et al Abstract 204 at 36th IDSA in *CID* Vol 27 No 4; Oct98

Common Pathogens Causing Diarrhea in Travelers to Mexico

	Organism	Percent
Bacterial	***Enterotoxigenic E. coli***	**40**
	Shigella spp.	**15**
	Salmonella spp.	**7**
	Enteroadherent E. coli	**7**
	Enteroinvasive E. coli	**< 5**
	Campylobacter jejuni	**< 5**
Viral	***Rotavirus***	**5-10**
	Norwalk virus	**5-10**
Parasitic	***Giardia lamblia***	**2**
	Entamoeba histolytica	**1**
	Cryptosporidium	**<1**
Unknown		**<5**

Ericsson and Johnson in Travel Medicine Advisor 2003

Escherichia coli

Serologically Defined

- O serogroup (lipopolysacharide)
- H serogroup (flagellar Ag)
- K serogroup (capsular Ag)
- > 171 O serogroups
- > 70 H serogroups

ETEC
Enterotoxigenic E. coli

- **Most common worldwide cause of Traveler's Diarrhea**
- **Source: "Fecalized" food >> water.**
  - **Need 10^8 to 10^{10} organisms to cause dz.**
- **Incubation: 24 - 72 hours**
- **Clinical: Profuse water diarrhea, nausea, cramps, low-grade fever x 3 - 5 days**
- **Labs: Fecal leukocytes, blood, and mucous are NOT present.**
- **Rx: Fluoroquinolones and rifaximin**
- **Pathogenesis: Heat labile (LT) and stable (ST) toxin produced.**
  - **LT toxin is molecularly similar to the cholera toxin.**

EHEC

The strain that made *E. coli* a household name

- Not a frequent cause of traveler's diarrhea
- O157:H7 strain assoc with most US cases of hemolytic uremic syndrome
- Source: undercooked ground meat, salami, milk, others. O157:H7 is frequently found in stool of cattle.
  - 1982 multi-state outbreak associated with hamburgers
  - Can be seen in institutional outbreaks
- Incubation: 24 - 72 hours
  - very infectious, 10-100 organisms
- Clinical: Bloody diarrhea and abdominal pain without fever
  - no mucosal inflammation on bx
- Labs: Stools with RBCs but no fecal leukocytes
  - NOT on most routine screens. Sorbitol MacConkey plates should be used for all bloody diarrhea
- Rx: Antibiotics may increase morbidity and mortality (15-20x > HUS).
- Pathogenesis: Cytotoxin produced resembles Shiga toxin of *Shigella*

E. coli Diarrhea
Other Strains

- **EIEC - *Enteroinvasive E. coli*:**
  - **Incubation: as short as 10 - 18 hours.**
  - **Clinical: indistinguishable from *Shigella* with severe abdominal cramping, watery diarrhea, tenesmus, and fever progressing to scanty stools with blood and mucous**
  - **Pathogenesis: produces Shiga-like toxins**
- **EaggEC - *Enteroaggregative E. coli*:**
  - **mainly infant diarrhea among indigenous population**
  - **increasingly recognized as a cause of traveler's diarrhea, often with resistant strains**
  - **May cause chronic diarrhea in children and HIV infected**
- **EPEC - *Enteropathogenic E. coli*:**
  - **first described category of *E. coli* diarrhea**
  - **almost exclusively in infants, esp developing countries.**

Shigellosis

Shigella spp

- **Four species associated with human disease**
  - ***S. sonnel*, *S. boydii*, *S. flexneri*, and *S. dysenteriae***
  - **All but *S. flexneri* are toxin mediated**
- **Source: Fecal-Oral. Food, water and person to person**
- **Incubation: 1 to 7 days (avg 3)**
  - **Ingestion of 10-100 organisms associated with disease**

Shigellosis
Shigella spp

- **Clinical: Diarrhea, fever, tenesmus, blood & mucous (vomiting in ⅓)**
  - **Typically biphasic:**
    - **Begins as frequent, high-volume, watery stools like *ETEC***
    - **Gradually lower volume, bloody, mucoid stools as colon involved**
- **Labs: fecal leuks and RBCs common, easily cultured**
- **Rx: quinolones, azithromycin**
- **Pathogenesis: Usually noninvasive but assoc with diffuse colitis**
  - **Penetration of intestinal mucosal epithelium; but no further extension**

Salmonellosis

Salmonella spp

- ***Salmonella*, one species with > 2000 serovars**
  - **thousands of serovars associated with gastroenteritis**
  - ***S. typhi* causes typhoid fever, other serovars cause nontyphoidal salmonellosis**
- **Source: eggs, poultry, meats and milk all can be contaminated**
  - **Developing world more often assoc with contact with infected human**
- **Incubation: variable and related to inoculum size (as few as 10 orgs)**
  - **as short as 6 hours, usually 12 - 36 hours, may be as long as 10 d.**

Salmonellosis

Salmonella spp

- **Clinical:** very varied among individuals, even for same strain.
  - No sx, constipated, watery diarrhea, bloody diarrhea, FUO
- **Labs:** Fecal WBS and RBCs, often invasive and diagnosed by blood cx
  - Bacteria shed for variable period of time, a few weeks to months or years. May be prolonged with treatment.
- **Rx:** not indicated in mild cases, quinolones and 3rd generation cephalosporins. Increasing problem with multidrug resistance.
- **Pathogenesis:** adherence and invasion

Typhoid
Salmonella typhi or paratyphi

- **< 500 cases/year in US, most from OCONUS**
- **estimated attack rate for travelers: 1 in 30,000**
- **Source: Transmitted by fecal or urinary contamination of food or water or hand to hand**
  - **Shellfish, milk products, hand carriage, filth flies often implicated sources**
- **Incubation varies with inoculum (3-60 days), typically 1-3 weeks**

Typhoid
Clinical Disease

- **Systemic illness with sudden onset**
  - **sustained fever, HA, malaise, anorexia**
  - **splenomegaly, lymphadenopathy**
  - **truncal erythematous rash “rose spots” (fleeting)**
  - **nonproductive cough**
  - **Constipation in 30%**
  - **Diarrhea eventually develops in ~50%**
  - **Arthralgias and myalgias**
  - **Abdominal pain, delirium and coma in some cases**
  - **Prior immunization does NOT prevent all cases**

- **Case fatality rate of approximately 15% of untreated**
  - **Often related to intestinal perforation**

- **Chronic carriers may occur even after asx dz, especially associated with gallstones and *Schistosomia hematobium***

Typhoid

- **Labs:** stool cultures are positive in ~30% of cases but often are negative by the time of symptoms
  - Blood cultures + in 40-80%
  - Bone marrow cultures highest dx yield (up to 98%)
  - Anemia and leukopenia are common
  - Elevated liver associated enzymes may resemble hepatitis
  - Serologic assays less reliable

- **Rx**: quinolones and azithromycin po in mild cases
  - 3rd generation cephalosporins

Campylobacteriosis
Campylobacter jejuni

- **Predominant cause of Traveler's Diarrhea n SE Asia > *ETEC***
  - **in North Africa and Mexico more common in winter/dry season**
- **Source: Poultry, dairy products, or unchlorinated water.**
  - **Exposure to a variety of live animals may also be a source.**
- **Incubation: 3 - 5 days, range 1 - 10 days.**
  - **Infective dose as little as 500 organisms**
- **Clinical: 2 - 5 day illness, typically over in 10 days but occasionally prolonged, lasting for weeks**
  - **Fever, abdominal pain, nausea, vomiting, diarrhea (often bloody)**
  - **Untreated typically shed organisms for 2 - 7 weeks**

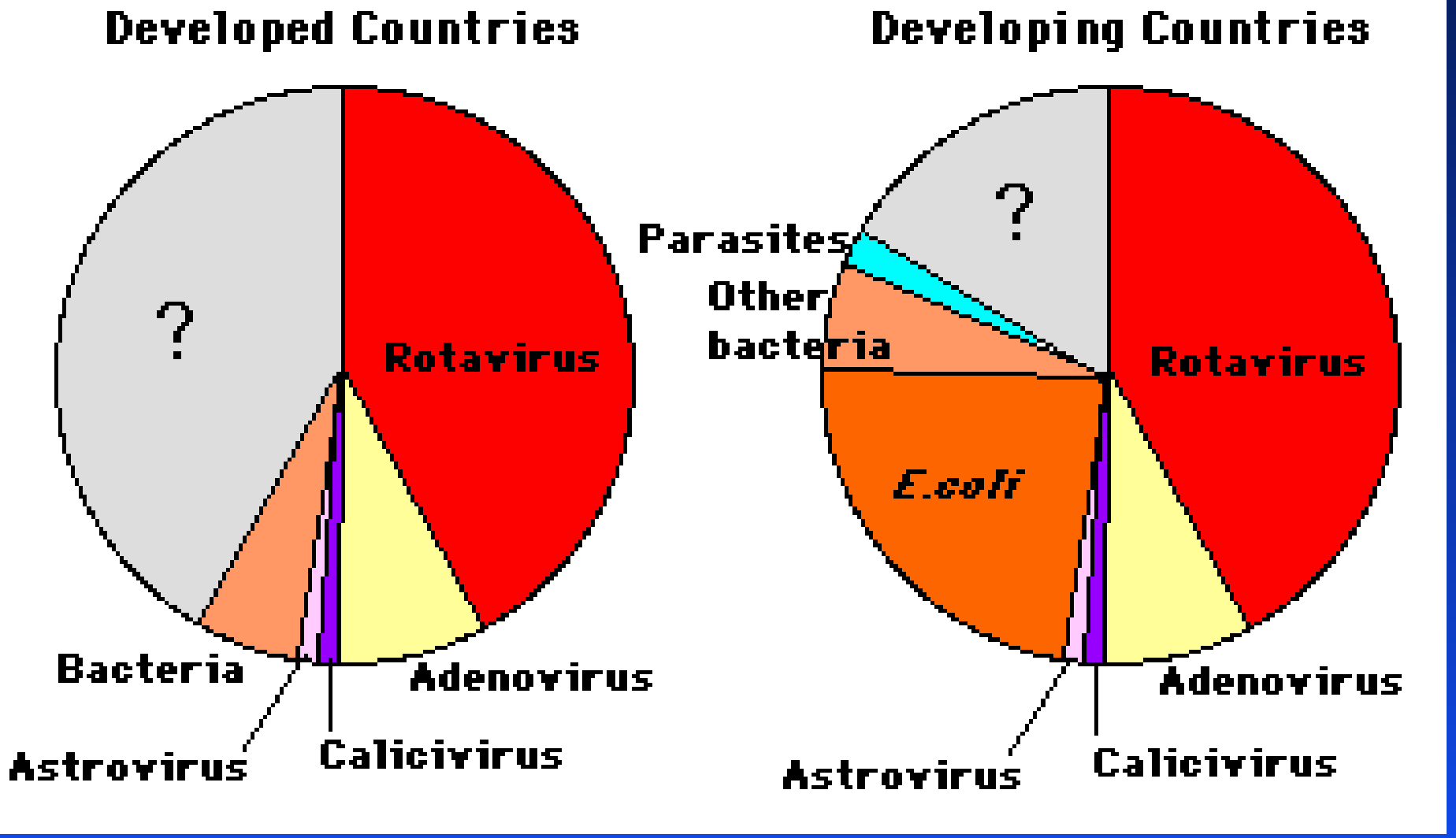
Campylobacteriosis
Campylobacter jejuni

- **Labs:** **fecal WBCs and RBCs; culture from stool on selective media**
- **Rx:** **azithromycin and quinolones but increasing resistance**
- **Pathogenesis:** **spiral morphology, long polar flagella allow rapid motility and corkscrewing thru gut mucous.**
- **Complications: Guillain-Barre Syndrome is associated with prior *Campylobacter* infection in 30-40% of cases**

Cholera
Vibrio cholerae

- **Most cases - asymptomatic infection (~ 95%)**
  - **Blood Group O more likely to develop severe disease**
  - **Achlorhydria increases risk Diarrhea - 500 to 1,000 ml/hr**
- **Fever - low-grade, if present (25%)**
- **Vomiting**
- **Tachycardia, hypotension and vascular collapse**
- **Dry tongue, oliguria, decreased skin turgor, sunken eyes, wrinkled fingers, raspy voice, acidosis, and Kussmaul breathing**
- **Infection to death from dehydration can occur in 24 hours**

Not all travel diarrhea is bacterial



Etiology of Diarrhea in Children < 24 months old

Norwalk Virus: Desert Storm

A Study of 883 USMC & Navy, Dec 90 - May 91

Symptoms	Norwalk ELISA
vomiting only	23.5%
vomiting & diarrhea	12%
diarrhea only	6.5%
neither	3%

JID 1993;167:986-7. Note: 61% had GI sx, 9.4% had 4-fold rise of ELISA sero

Cruise Ship Associated Diarrhea

- Norwalk-like Viruses (Norovirus)
- Frequently spread via fomites
- Hand washing is most important
- Increased number of children on cruise ships probably plays a role

“Noro” Virus Diarrhea

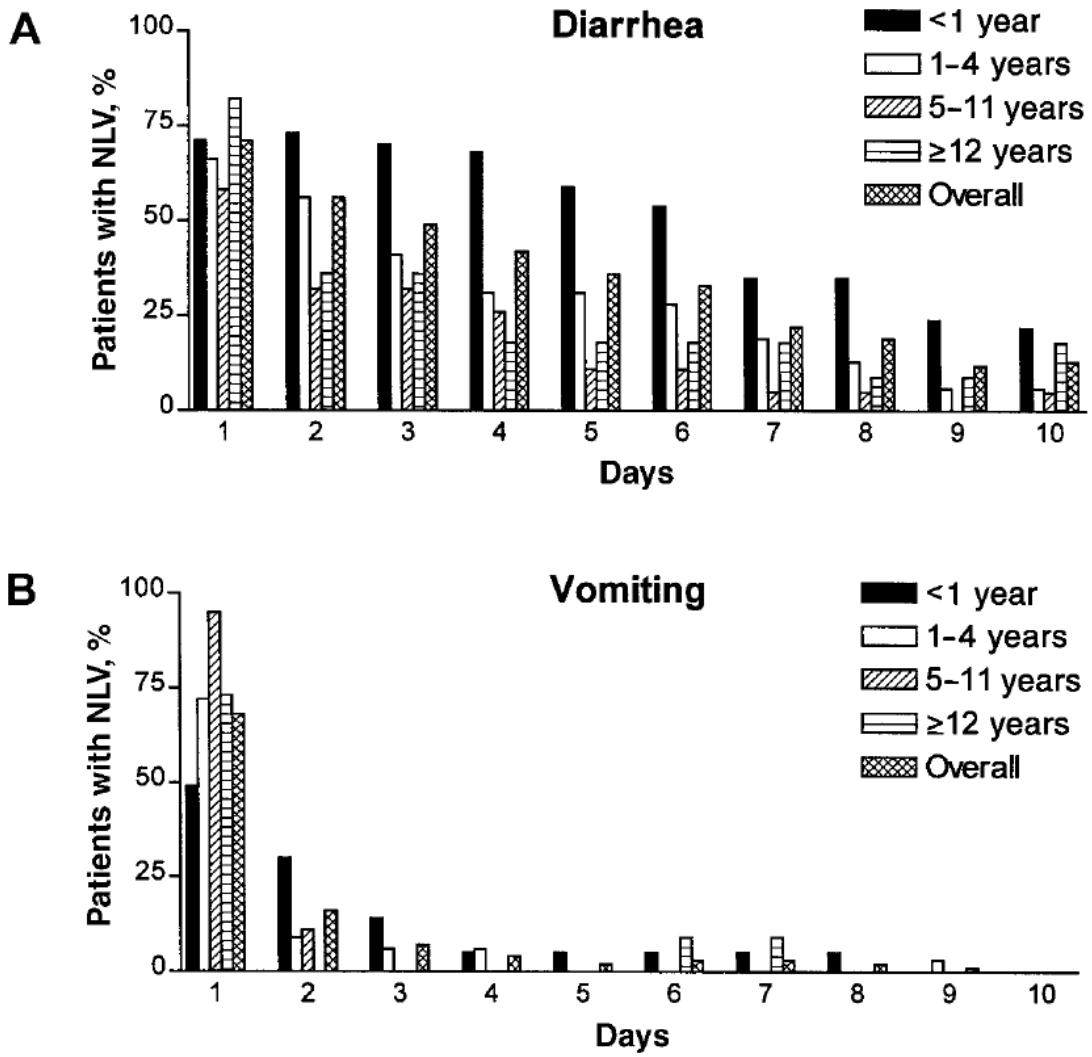


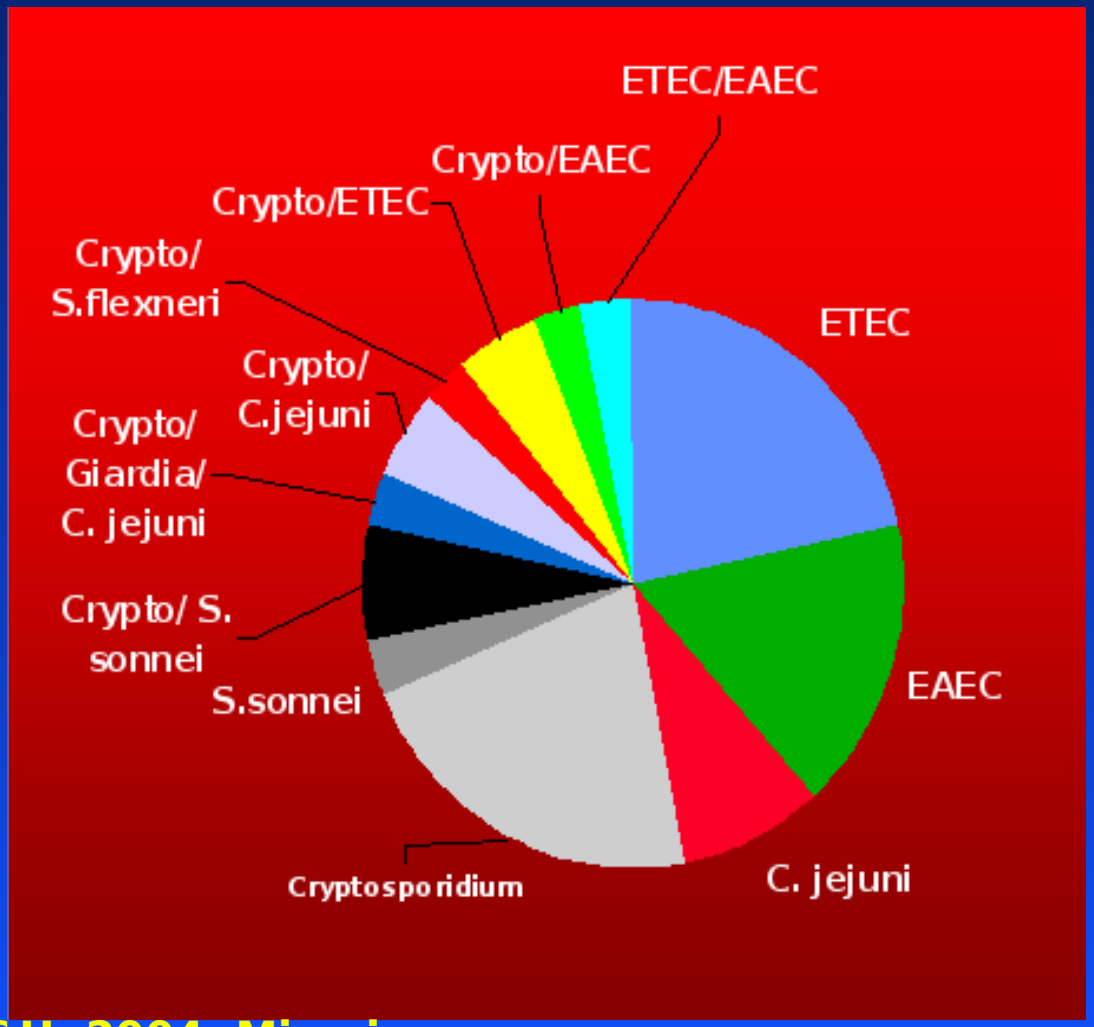
Figure 2. Proportion of Norwalk-like virus (NLV) cases associated with diarrhea *(A)* or vomiting *(B)* in patients aged <1, 1–4, 5–11, and ⩾12 years

Rockx et al CID 2002; 35:246–53

Enteropathogens in Cusco, Perú

Parasites may be quite common

- 78 travelers from developed countries visiting Cusco, Perú
- 62% of those with diarrhea had a pathogen isolated
  - Multiple pathogens were found in 29%
  - Cryptosporidium was the most common pathogen found in 48% (of positive specimens)



Cabada et al. Abstracts ASTM&H, 2004. Miami, Florida

Food “Poisoning”

Staph aureus

- Pre-formed heat-stable toxin

- Dx: vomiting and diarrhea 1 - 4 hours after ingestion

Clostridium perfringens

- Nausea, no vomiting, abdominal cramps, and watery diarrhea 8 - 16 hours after ingestion

Bacillus cereus

- Mimics staph, and can also mimic *C. perfingens*

- Associated with ingestion of re-cooked rice

Drug-Resistant Traveler's Diarrhea?

615 Bacterial Isolates in US Students with TD Summering in Guadalajara

	1988	1997
Ampicillin	38%	58%
Doxycycline	31%	69%
Furazolidone	21%	69%
Trimethoprim	3.4%	71%
Fluoroquinolones	3.4%	71%

DuPont et al Abstract 204 at 36th IDSA in *CID* Vol 27 No 4; Oct 98

Traveler's Diarrhea
Empiric Treatment in Adults

Severity	Antibiotic	Antimotility Agent
Mild (1 – 2 loose stools without fever or blood)	Not indicated	Observe or loperamide 2 mg after each loose stool or bismuth subsalicylate 2 qid
Moderate (< 3 BMs without fever or blood)	Consider quinolones, single dose or standard dose x 3 days	Loperamide or bismuth
Moderate to Severe (> 3 BMs with fever and/or cramping)	Quinolones, eg levofloxacin 400 mg po qd, consider single dose	Loperamide or bismuth
Severe (> 6 BMs with fever and/or heme, tenesmus)	Quinolones for five full days	Avoid unless close observation

Quinolones are generally considered best. Levoflox lower MICs than ciproflox
In some areas, esp SE Asia,> 80% of *Campylobacter* is quinolone resistant but responds to azithromycin 500mg po qd x3.

Traveler's Diarrhea in Children
Empiric Treatment in Children

- **Controversial due to increased risk of HUS in *EHEC* cases treated with antibiotics**
- **TMP/SMX is generally recommended, but high levels of resistance in the tropics (and increasing worldwide)**
- **If child did not respond to TMP/SMX, consider using cefixime or azithromycin.**
  - **Ceftriaxone can also be used IM or IV once daily**
- **Quinolones are not approved in < 16 yo, but contraindications are mainly from animal studies.**

Azithromycin for Diarrhea?

Single dose 1000 mg azithro vs 500 mg levo

Table 2. Microbiologic outcome after treatment with azithromycin or levofloxacin in US students who acquired travelers' diarrhea in Guadalajara, Mexico.

Pathogen	Azithromycin group (n = 105)		Levofloxacin group (n = 106)	
	No. of subjects with pathogen identified	Microbiologic cure, % of subjects	No. of subjects with pathogen identified	Microbiologic cure, % of subjects
ETEC alone	55	55	57	61
Shigella species	1	100	3	100
Salmonella species	1	100	2	100
Shigella species and ETEC	5	80	8	100
Salmonella species and ETEC	0	0	1	100
Any bacterial pathogen	62	58	71	69

NOTE. Denominators used to calculate percentages of subjects with microbiologic cure may differ from overall no. of subjects in whom pathogens were identified, because posttreatment samples were not always available. ETEC, enterotoxigenic *Escherichia coli*.

Azithromycin (105 subjects) vs. levofloxacin (106 subjects) for treatment of travelers' diarrhea (percentage remaining with diarrhea after initiation of therapy). Study performed in Guadalajara, Mexico

Adachi et al. Clin Infect Dis 2003; 37:1165-71

Pre Travel Antibiotics for Diarrhea

Is there a role for true prophylaxis?

- **Controversial**
- **Extremely high risk with short term, mission essential orders could consider:**
  - **Quinolones - avoid**
  - **Azithromycin - avoid**
  - **Bismuth – reasonable but side effects**
  - **Rifaximin – reasonable but expensive**
- **Risk of side effects may be substantial**
- **False sense of assurance → higher risk behavior**
- **Does not prevent viral, protozoal or helminthic infections**
  - **may increase likelihood of *Salmonella* infections**

Other PreTravel Recs to Decrease TD

- **Warn against unnecessary use of agents that decrease gastric acidity**
  - **The first line of defense against infection is gastric acidity**
  - **May decrease the infective dose 10-1000 fold**
- **Encourage frequent use of alcohol based handwashing agents like *Purell.***
- **Discuss water purification with trekkers or small group deployed.**

What Happens to all the Meds Dispensed?

Table. Use of Ciprofloxacin by Travelers (N = 70)

Measure Taken	Number	% of All Filled Prescriptions
Used all of the ciprofloxacin for:		
Travelers' diarrhea	2	2.9
Sore throat, fever	1	1.4
Used part of the ciprofloxacin for:*		
Travelers' diarrhea	5	7.1
Gas, bloating, or upset stomach	2	
Did not use any ciprofloxacin, but:		
Stored unused pills	40	57.1
Disposed of pills	13	18.6
Donated pills	2	
Unknown	2	
Other	3	4.3
Gave to a friend	1	
Gave to dog	1	
Lost	1	

* Of these 7 patients, 6 stored and 1 disposed of the remaining pills.

Day LJ - *Am J Med* - 15-JUN-2003; 114(9): 771-2

Work up for Diarrhea

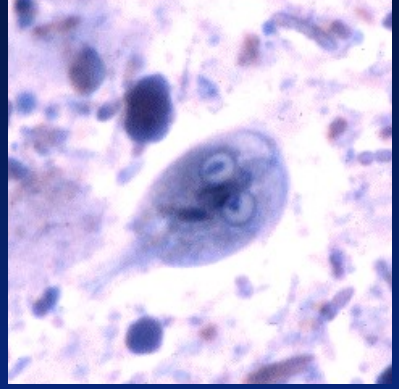
- **Depends on the setting**
  - **Deployed with access to some lab:**
    - **Worthwhile to get stool cx and sens for initial cases to help define what pathogens are present and which therapy to use**
  - **Deployed with no lab but massive outbreak:**
    - **Collect stool in 3-5 cases and attempt to get sent to local lab or back to CONUS for w/u**
    - **Acute and convalescent serology may make dx**
  - **In CONUS with lab capability:**
    - **Typically viral, may not need antibx at all, if sporadic and mild dz, would not w/u**
    - **If large outbreak, worthwhile to check stools and possibily serology to determine etiology for future cases**

Post-Travel Diarrhea
Chronic

- **Diarrhea continuing for two weeks or longer usually presents after return from travel.**

- **Consider possible protozoal etiologies as more likely in this group:**
  - ***Giardia lamblia* is the most common.**
  - ***Entamoeba histolytica***
  - ***Cryptosporidium parvum***
  - ***Isospora belli***
  - ***Cyclospora cayetanensis***

- **Need fresh stool examined with conventional and modified acid fast staining.**
  - **May need repeated exams (three pick up > 90%).**
  - **May end up treating presumptively.**

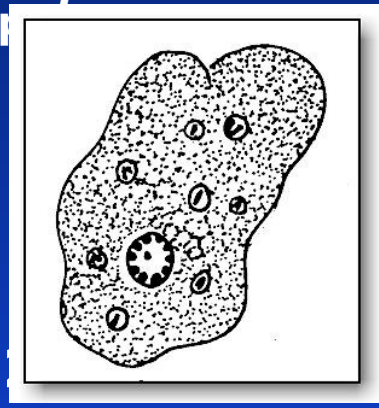


Giardiasis

- **The most prevalent enteric parasite in the US and Canada**
  - **~4% of 300,000 stool specimens**
- **In the developing world one of the 1st infections in infants**
  - **Peak prevalence rates 15-20% in children <10 yo.**
- **Generally water borne and probably carried by many animals**
- **Consider in all patients with prolonged diarrhea, especially if associated with malabsorption or weight loss.**
- **Dx with a stool EIA (more sens. than microscopy, esp. if inexperienced)**
- **Treat with metronidazole 250mg tid x 5 days or tinidazole 2.0 g x1.**
  - **Albendazole is alternative for metronidazole tolerant strains**
  - **Furazolidone 100 mg qid x 7d (available as suspension but $$$)**
  - **Nitazoxanide 500 mg po q 12 h x 3d (newly available in US)**

Amebiasis
Entamoeba histolytica

- ***E. histolytica* - very prevalent in Mexico, India, Africa, Central and S. America**
  - **morphologically indistinguishable but commensal, *E. dispar* causes far more infxns but is not associated with symp**



- **Routes of transmission:**
  - **Contaminated food and water**
  - **Direct fecal-oral contamination**

- **Symptomatic dz in 80-98% and invasive dz in**
  1. **Dysentery with small vol, bloody stools and fecal leuks**
  2. **Colitis with ulcerations of the mucosa and flask-shaped abscesses**
  3. **Formation of a fibrotic mass in the intestinal wall – ameboma**
  4. **Hematogenous spread of trophs to R lobe of the liver, brain, pericardium and lung**
  - **Chronic amoebic colitis is indistinguishable from inflammatory bowel dz**
    - **Use of steroids in these patients may lead to toxic megacolon and perforations**

Okhuysen CID 2001;33:110-4

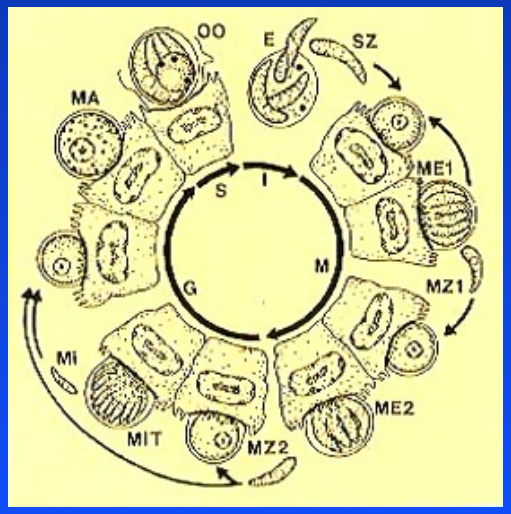
Amebiasis

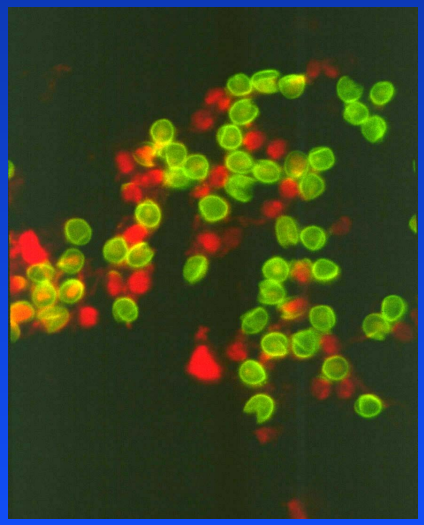
Entamoeba histolytic

- **Diagnosis**
  - **Fresh stool examination with Trichrome stain or PAS stain of colon bx**
  - **Fecal Ag studies using ELISA are needed to distinguish from *E. dispar***
- **Treatment**
  - **Metronidazole 750 tid x 10 d**
  - **Tinidazole 1.0 g bid x 3 d**
  - **Above work in tissue but are not luminal agents and must be followed by paromomycin 500 mg po tid x 7 d.**
  - **Nitazoxanide probably effective but not considered superior to metronidazole.**

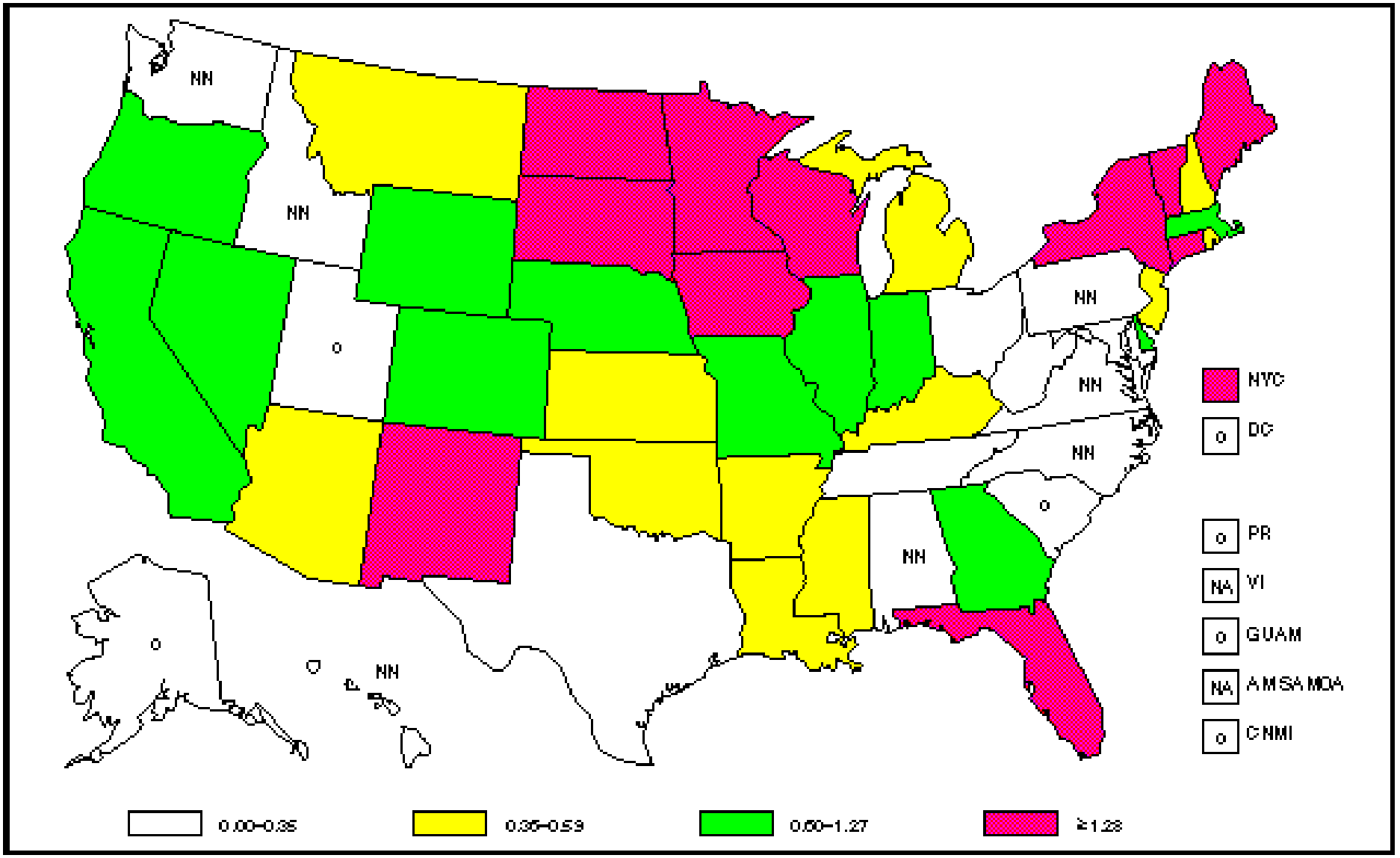
Cryptosporidiosis
Cryptosporidium hominis and *C. parvum*

- Protozoan pathogen of the small bowel increasingly recognized worldwide.
- 30-50% of US population with Ab
- 60-85% of developing countries pop. have Ab
- Often associated with water contaminated by cattle feces
  - Primarily infects neonatal animals
  - ~64 quadrillion cysts from US cattle annually



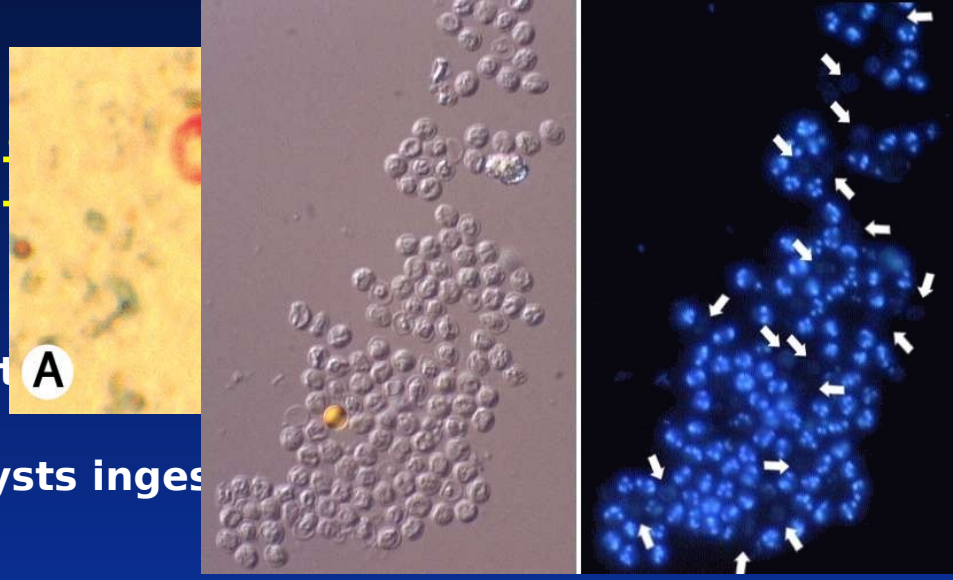


CRYPTOSPORIDIOSIS — reported cases per 100,000 population, United States and territories, 1997



Surveillance data from 1997 suggest that infection with cryptosporidium is geographically widespread. The highest reported rates were primarily in the north central and northeastern states. As in 1995 and 1996, cases primarily were reported in the late summer among children and adolescents aged <16 years.

Cryptosporidiosis

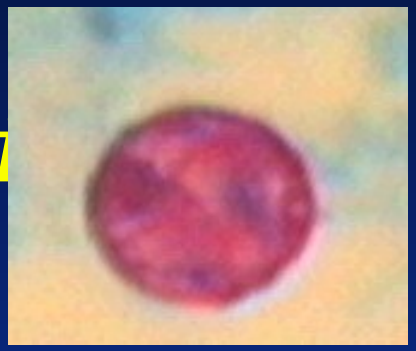


- Rapid incubation, ~3 days post ingest
- Highly infectious with as few as 10 cysts inges
- Resistant to chlorine
- Self limited dz in immunocompetent, usually 5-7 days
  - Profuse watery diarrhea
  - Fatigue, malaise
  - Low grade fever
  - Nausea and vomiting in <20%
- Neonates, elderly and immunocompromised may have chronic diarrhea
- Diagnosis with modified acid fast stain or, more commonly stool EIA
- No therapy indicated (or very effective) in immunocompetent
  - In immunosuppressed with chronic diarrhea may try combination of azithromycin and paromomycin
  - Nitazoxanide 500 mg bid appears to be first effective drug (for chronic cases)

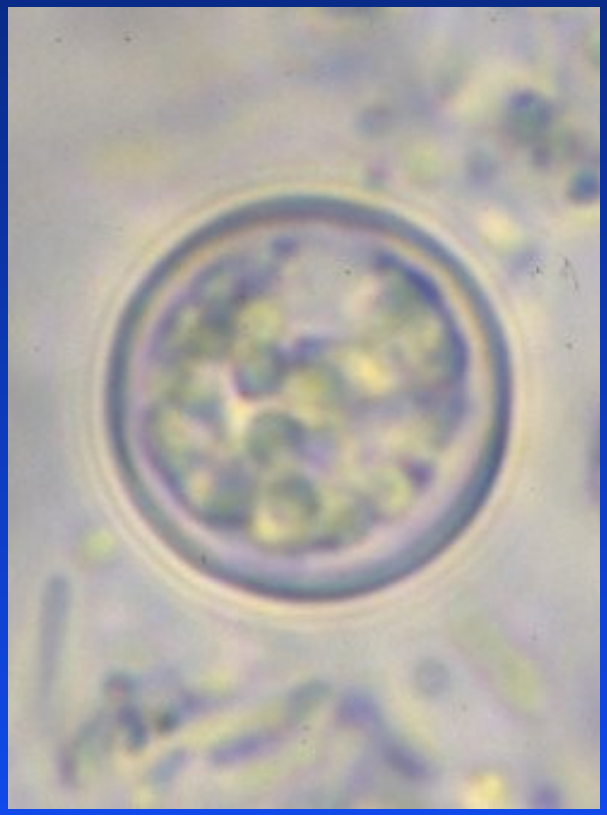
Leav et al. Clin Infect Dis 2003; 36:903–8

Cyclospora cayetanesi

- **Increasingly recognized as a cause of chronic diarrhea in travelers**
- **Associated with US foodborne outbreaks (raspberries & lettuce)**
- **Small bowel pathogen with sx similar to Giardia**
- **Waxing and waning course**
  - **diarrhea, nausea, anorexia, fatigue, malaise and weight loss**
- **Rx: TMP/SMX for 1 week.**



Acid fast stain oocyst



Sporulated oocyst

Chronic Diarrhea
Helminths

- **Uncommon in most short term travelers**
  - **more common in those who return after months to years in the developing world**
- ***Ascaris, Strongyloides*, *Trichuris, Necator* and *Ancyclostoma* (hookworm) are the most common**
- **Light infections are typically asx after pulmonary phase has passed**
- **Heavy infestations are more likely to be symptomatic and are easier to dx.**
- **If scant number of eggs/larva then think about other undx orgs**
  - **ie. *Giardia, Entamoeba, Cryptosporidium***

Diarrhea in Travelers or Deployed

Work Up

Initial W/U

- Fresh stool sample
  - Not refrigerated overnight
- Fecal leukocytes
- Fecal occult blood
- Fecal lactoferrin

After initial W/U

- Culture and sensitivity
- EIA for Giardia and Cryptosporidium
- Stool microscopy for O&P (up to 3x)
  - If not examined fresh then fix immediately
  - Trichrome
  - Modified AFB

Water Disinfection for International and Wilderness Travelers

- **Heat is still the best way to inactivate all organisms in water**
- **Time consuming**
- **Fuel needed**
- **May disclose location if operational**

Organism	Lethal temperature and time
Giardia species	55°C[a] for 5 min 50°C for 10 min (95% inactivation) 60°C for 10 min (98% inactivation) 70°C for 10 min (100% inactivation)
Cryptosporidium species	64°C within 2 min 72°C heated up over 1 min
E. coli, and *Salmonella*, *Shigella*, and *Campylobacter* species	65°C[b] for 3 min
Vibrio cholerae	60°C for 10 min 100°C for 10 s
E. coli	60°C for 5 min 70°C for 1 min
Enteric viruses	56°C–60°C for 20–40 min <1 min at ⩾70°C[c]
Hepatitis A virus	98°C for 1 min 85°C for 1 min

Backer. CID; 2002; 34:355-64

Table 3. Susceptibility of microorganisms to filtration, by size.

Organism	Approximate size, μm	Maximum recommended filter rating, μm
Virus	0.03	NA[a]
Escherichia coli	0.5 × 3–8	0.2–0.4
Campylobacter species	0.2–0.4 × 1.5–3.5	0.2–0.4
Vibrio cholerae	0.5 × 1.5–3.0	0.2–0.4
Cryptosporidium oocyst	2–6	1
Giardia cyst	6–10 × 8–15	3–5
Entamoeba histolytica cyst	5–30	3–5
Nematode egg	30–40 × 50–80	20
Schistosome cercariae	50 × 100	Coffee filter or fine cloth
Dracunculus larvae	20 × 500	Coffee filter or fine cloth

[a] Not applicable to most portable filters; only reverse-osmosis membranes exclude viruses by virtue of pore size.

Table 4. Recommended contact time for specified halogen concentration, according to water temperature.

Halogen concentration	Contact time, min		
	At 5°C	At 15°C	At 25°C
2 ppm	240	180	60
4 ppm	180	60	45
8 ppm	60	30	15

NOTE. Contact times are extended from the usual recommendations to account for (1) uncertainty about the presence of residual halogen and (2) the time required to kill *Giardia* cysts in very cold water.

Halogen type, organism	Concentration, mg/L[a]	Time, min	Temperature, °C	Disinfection constant, Ct
Chlorine				
Escherichia coli	0.1	0.16	5	0.016
Campylobacter species	0.3	0.5	25	0.15
20 enteric viruses	0.5	60	2	30
Hepatitis A virus	0.5	5	5	2.5[b]
Entamoeba histolytica cysts	3.5	10	25	35
Giardia cyst	2.5	60	5	150
Cryptosporidium oocyst	10	720	20	1440
Schistosome cercariae	1.0	30	28	30
Iodine				
E. coli	1.3	1	2–5	1.3
E. histolytica cyst	3.5	10	25	35
	6.0	5	25	30
Poliovirus 1	1.25	39	25	49
Coxsackie virus	0.5	30	5	15
Giardia cyst	4	15	30	60[c]
	4	120	5	480[c]

NOTE. Most experiments use a 2–3-log (99%–99.9%) reduction as the end point.

[a] Residual concentration of active chlorine disinfectant compounds.

[b] End point of 4-log reduction.

[c] A 100% rate of killing organisms; viability tested only at 15, 30, 45, 60, and 120 min.

Table 6. Dose of halogen for field-water disinfection.

Method of disinfection	Amount of halogen administered (no. of drops[a])			
	For 4 ppm	For 5 ppm	For 8 ppm	For 10 ppm
Iodination added to 1 L or qt of water				
Iodine tablets (tetraglycine hydroperiodide; e.g., EDWGT, Potable Aqua, and Globaline)[b]	1/2 tablet	—	1 tablet	—
2% Iodine solution (tincture)	0.2 mL (5)	—	0.4 mL (10)	—
10% Povidone-iodine solution	0.35 mL (8)	—	0.70 mL (16)	—
Saturated solution (iodine crystals in water; e.g., Polar Pure[c])	13 mL	—	26 mL	—
Chlorination added to 1 L or 1 qt of water				
Household bleach 5%; sodium hypochlorite	—	0.1 mL (2)	—	0.2 mL (4)
Chlorine tablets (sodium dichloroisocyanurate [e.g., AquaClear[d]])	—	—	—	1 tablet
Chlorine plus flocculating agent (e.g., AquaCure, AquaPure, or Chlor-Floc[e])	—	—	1 tablet	—

NOTE. EDWGT, emergency drinking water germicidal tablet.

[a] Measured with a dropper (1 drop = 0.05 mL) or a small syringe.
[b] Manufactured by Coghlan's Ltd., Wisconsin Pharmacal, and Van Ben Industries, respectively.
[c] Manufactured by Polar Equipment.
[d] Manufactured by Gal Pharmaceuticals.
[e] Manufactured by Safesport, World Resources, and Control Chemical, respectively.

Table 8. Choice of filtration method for types of water from various sources.

Primary concern and filtration method used	"Pristine" water in the wilderness	Tap water in developing country	Water in a developed or developing country	
			Clear surface[a]	Cloudy
Primary concern				
Giardia species, enteric bacteria	X	—	—	—
Bacteria, *Giardia* species, small numbers of viruses	—	X	—	—
All enteric pathogens, including *Cryptosporidium* species	—	—	X	—
Unpleasant taste plus microorganisms	—	—	—	X
Method used				
Heat	X	X	X	—
Filtration[b]	X	X	—	—
Halogen	X	X	—	—
Coagulation-flocculation followed by a second step (heat, filtration, or halogen)	—	—	—	X
Filtration plus halogen[c] (done in either order)	—	—	X	—

[a] Found near areas of human and animal habitation; includes agricultural runoff (from cattle grazing) or sewage treatment effluent (from upstream villages or towns).

[b] Filtration alone is adequate for eliminating *Cryptosporidium* species introduced by cattle grazing in high-quality wilderness.

[c] May include iodine resin filters (for considerations, see the "Iodine resins" subsection of the "Halogens" section of the text).

Diarrhea Prevention
Closing Points

- **Education prior to travel**
  - **food, water, hygiene issues for patients**
  - **knowledge of diarrhea epidemiology for the health provider**
- **Treatment**
  - **Proper antibiotic for primary pathogens**
  - **Antimotility agents in conjunction**
- **Work up of cases**
  - **Handling of specimens**

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